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DRAWINGS ATTACHED

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(54) ELECTRIC HEATING ELEMENT

(71) We, FUJI SHASHIN FILM KABUSHIKI KAISHA, a Japanese Company of, No. 210, Nakanuma, Minami-Ashigara Machi, Ashigara-Kamigun, Kanagawa, Japan, do hereby

declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to an electrical heating element using a strip or ribbon-shaped electrical resistance heating member. In the previously known electrical heating elements using a strip or ribbon-shaped electrical resistance heating member (which will hereinafter be referred to as an "electrical heating strip"), an electrical heating strip is wound round a heat resisting and electrically insulating mica sheet in the form of a spiral and is sandwiched between other mica sheets. Use of such an electrical heating element has hitherto been limited to devices such as to domestic irons.

More especially, the invention is concerned with an electrical heating element utilizing the fact that a strip-shaped resistance heating member has a directional heat radiating surface and good heat radiation properties.

The invention provides an electrical heating element comprising an elongated hollow member of an infrared ray transmitting and heat resisting vitreous or crystalline glass material and a ribbon shaped strip of electrically conductive material extending longitudinally within said member, the said strip having at least one bent portion intermediate its ends extending away from the main plane of the strip, said bent portion or portions engaging an internal surface of said hollow member to maintain the major portion of said strip out of contact with the hollow member.

The invention is illustrated by way of example in the accompanying drawings, in which:

Figs. 1 and 2 are diagrammatic perspective views of embodiments of the invention,

Figs. 3 and 4 are enlarged fragmentary cross sectional views of the electrical heating elements of Fig. 1 and Fig. 2 respectively, and

Fig. 5 is a diagrammatic perspective view showing a flat plate heating body in which electrical heating elements according to the invention are assembled.

Referring to Fig. 1 and Fig. 3, an electrical heating element comprises a tube 1 of heat resisting glass such as quartz glass or crystalline glass and an electrical heating strip 12, having V-shape bends 13, arranged in the tube 1. The bent portions 13 of the electrical heating strip extend in one direction only. Figs. 2 and 4 show another embodiment of the electrical heating element, in which 21 is a tube of a heat resisting glass similar to the tube 1, 22 is an electrical heating strip and 23 is a bent portion extending on both sides thereof.

Since the electrical heating element of the invention is constructed in the manner described, the heat generated by the electrical heating strip, in particular the primary radiant rays, can be utilized effectively when the electrical heating strip is so arranged that a flat surface thereof faces an object to be heated. Moreover, the thermal expansion of the electrical heating strip due to heat generated thereby is absorbed due to the provision of the bent portions 13, 23 in the electrical heating strip 12, 22. Even when the electrical heating strip is thermally expanded, only the bent portions come into contact with the inner wall of the glass tube. Therefore the contact area of the strip with the tube is so small that the heat generated in the electrical heating strip is not greatly reduced by thermal conduction.

In the embodiment of the invention shown in Fig. 5, the electrical heating elements are arranged in the form of a flat plate to form a surface heater. A number of electrical heating elements 3 are arranged parallel to one another, and both ends thereof are held by heat resisting reinforcing members 4, 4′ which have approximately the same coefficient of thermal expansion as that of the tubes 1 and are bonded thereto by a heat resisting adhesive.

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The electrical heating strips of each electrical heating element 3, with the exception of the bent portions, lie in the same plane, and they are electrically connected in series throughout the whole surface heater. Lead wires 5, 5' for supplying electric power to the electrical heating strips are fitted to the ends of electrical heating elements of the heating plate. The electrical points of the electrical heating strips are encased in a heat resisting cement. A plate 6 for reflection of heat rays is arranged beneath the plate-like array of electric heating elements, thus forming a surface heater. This surface heater is sufficiently thin and has a sufficiently large heating area that it is possible to emit heat rays upwards and to heat uniformly a large area. Since each electrical heating strip hardly makes contact with the inner wall of the glass tube and, consequently, the heat loss is low, such a surface heater is suitable for use as a heat source of an infrared ray heater or foot warmer which requires a rapid rising of temperature.

The invention is further illustrated in the following Example.

A batch of thirty four glass tubes of crystalline glass having a diameter of 4.5 mm, thickness of 0.6 mm and length of 153 mm were arranged as shown in Fig. 5, said batch consisting of LiO_2—Al_2O_3—SiO_2 type glass to which ZrO_2 was added as a nuclei-forming agent, and both ends of the glass tubes were bonded to reinforcing tubes of the same material having a diameter of 2 mm, by means of an adhesive consisting of 85 parts of a powder having the same composition as the glass batch and 15 parts of kibushi clay. Then, after drying, the glass tubes were subjected to heat treatment at a temperature of at most 880°C for 2 hours to obtain a surface heater crystallized to transparency. In the central twenty eight tubes of the array of thirty four crystallized tubes were inserted electrical heating strips of NTN No. 4 Fe—Cr—Al (trade name, manufactured by Nippon Metal Industry Co., Ltd.), which is an alloy containing 23—27 weight % chromium, 2—4 weight % aluminium and the balance iron, having a volume resistivity of 123 $\mu\Omega$/cm each having a width of 1.4 mm and thickness of 0.17 mm and having bent portions as shown in Fig. 3 about 40 mm apart. The electrical heating strips, with the exception of the bent portions, were arranged so as to be in the same plane, and were connected in series by electrical spot welding. Lead wires were then fitted to the extreme outer strips within the twenty eight tubes, electrical insulation of the joints between the electrical heating strips was carried out by encasing the joints and both ends of the glass tubes, with the exception of the lead wires, in an air-hardening cement. A reflecting plate of aluminium 200 mm square and 1 mm thick was arranged on one side of the flat array of glass tubes 20 mm away therefrom. In operation, 100 volts AC was applied to the lead wires.

The power consumption in heat equilibrium was 400 Watts and the surface temperature under the central part of the surface heater was 410°C. Rising of the surface temperature was so rapid that it reached 300°C in only 2 minutes. Elongation of the electrical heating strips enclosed in the tubes was absorbed by means of the bent portions thereof, so that contact of the electrical heating strip with the inner wall of the glass tube over a substantial area did not occur. The distribution of temperature was uniform to within a range of about 30°C. The surface load density of the electrical heating strips was 3.0 W/cm² and about 1.8 W/cm² per unit area of the electrical heating element.

As mentioned above, the electrical heating element of the invention is very suitable for use as an electrical heating element of an infrared heater, since the heat radiation is directional and the heat loss due to conduction is very small. Moreover, the electrical heating element of the invention can be designed not only as a flat plate type heater, but also in various forms with various characteristics.

WHAT WE CLAIM IS:—

1. An electrical heating element comprising an elongated hollow member of an infrared ray transmitting and heat resisting vitreous material or crystalline glass material and a ribbon shaped strip of electrically conductive material extending longitudinally within said member, the said strip having at least one bent portion intermediate its ends extending away from the main plane of the strip, said bent portion or portions engaging an internal surface of said hollow member to maintain the major portion of said strip out of contact with the hollow member.

2. An electrical heating element as claimed in Claim 1, in which the said strip has a plurality of bent portions spaced along its length.

3. An electrical heating element as claimed in Claim 2, in which the said bent portions extend in opposite directions, relatively to the plane of the strip, in order, by engagement with opposite internal surfaces of said hollow member, to maintain the major portion of the said strip out of contact with the hollow member.

4. An electrical heating plate, formed by a plurality of heating elements as claimed in any one of Claims 1—3, arranged laterally adjacent one another, the planes of the said ribbon shaped strips being substantially parallel to the plane of the plate.

5. An electrical heating element substantially as described herein with reference to Figures 1 and 3 or Figures 2 and 4, of the accompanying drawing.

6. An electric heating plate, substantially as herein described with reference to Figures 1, 3 and 5 or Figures 2, 4 and 5 of the accompanying drawings.

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1261748 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1

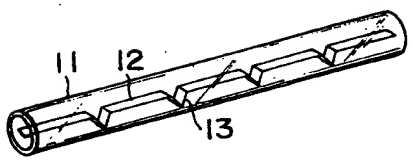

FIG. 2

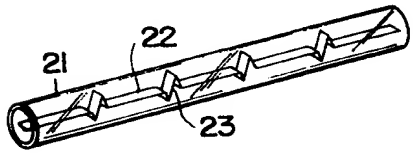

FIG. 3

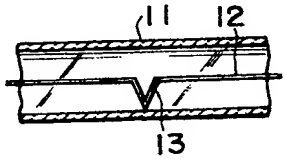

FIG. 4

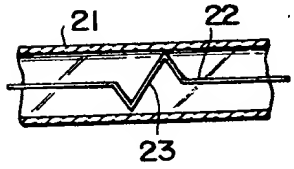

FIG. 5